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STOMACH CONTENTS OF BEACH CAST CETACEANS COLLECTED ALONG THE SAN DIEGO COUNTY COAST OF CALIFORNIA, 1972-1991

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ADMINISTRATIVE REPORT LJ-92-18

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STOMACH CONTENTS OF BEACH-CAST CETACEANS COLLECTED ALONG
THE SAN DIEGO COUNTY COAST OF CALIFORNIA, 1972-1991

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Stomach contents of beach-cast cetaceans collected along
the San Diego county coast of California, 1972-1991

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ABSTRACT

We examined the stomach contents of 77 cetaceans stranded along the San Diego County coast from 1972 to 1991. Eight species of cetaceans were collected: common dolphin, bottlenose dolphin, Pacific white-sided dolphin, striped dolphin, short-finned pilot whale, gray whale, pygmy sperm whale, and Cuvier's beaked whale. We used fish otoliths, cephalopod beaks, and crustacean exoskeletons recovered from the stomachs to identify species of prey. Market squid (Family Gonatidae) and several species of croaker (Family Sciaenidae) were the most common prey items identified. One of the Pacific white-sided dolphin stomachs collected was particularly notable in that many prey remains were recovered from both the forestomach and main stomach. Our results are similar to the findings of previously published reports that describe the food habits of these cetacean species found along the coast of southern California.

INTRODUCTION

Identifying the prey of a cetacean species provides information concerning preferred habitat, distribution and movement patterns, and niche partitioning. For small cetaceans, feeding habits are often determined from prey remains recovered from the stomachs of dead animals (e.g., Fitch and Brownell, 1968; Jones, 1981; Stroud et al., 1981). Along the southern California coast, beach-cast specimens of cetaceans are collected as part of a stranding network that was officially established in 1979 (Henderson and Hansen, 1983). The purpose of this paper is to describe the stomach contents of the beach-cast cetaceans collected along the coast of San Diego County, California. We have identified the recovered prey remains to the lowest taxonomic level possible and have summarized previously published information on the distribution of prey commonly taken by the eight species of cetaceans in our sample.

METHODS

Data Collection

Cetacean strandings have been recorded along the San Diego County coast by the Southwest Fisheries Science Center (SWFSC) since 1966 (Hansen, 1983; Henderson and Hansen, 1983), but the availability of stomachs for this study only dates to 1972. There have been 257 beach-cast specimens collected between 1972 and 1991 of which 120 had only minimal data (i.e., species, sex, length, and location) and 137 specimens had a more extensive set of data and tissues collected, including the stomach. A number of specimens were not available to us for this study: 21 were given to the Los Angeles County Natural History Museum, 15 to the Naval Ocean Systems Center, three to the National Museum of Natural History (Smithsonian Institution), two to San Diego Natural History Museum, and three to three different organizations. No records are available for 16 beach-cast specimens that reportedly had stomachs collected. Of the 77 collected stomachs that we had access to, 36 had been examined prior to this study, and we had access to the notes and the collected prey items for these specimens. Represented in the collection were eight species of cetacean, including the Baja neritic and northern temperate stocks of common dolphin, Delphinus delphis; bottlenose dolphin, Tursiops truncatus; Pacific white-sided dolphin, Lagenorhynchus obliquidens; striped dolphin, Stenella coeruleoalba; short-finned pilot whale, Globicephala macrorhynchus; gray whale, Eschrichtius robustus; pygmy sperm whale, Kogia breviceps; and Cuvier's beaked whale, Ziphius cavirostris.

Stomach Contents

We examined 41 stomachs for prey items, in addition to the 36 stomachs previously examined. Processing included repeated rinsings of the stomach compartments with water and thorough checking of the folds in the stomach lining to ensure that all prey items were removed. The contents of the esophageal forestomach and the main stomach were recovered separately. During the rinsing process, a series of sieves with metal-mesh openings ranging in size from 500 μ m to 12.5mm were used to recover prey remains. We collected fish otoliths, cephalopod beaks, and crustacean claws, as well as whole prey and any unusual non-food items that were present. The otoliths were air dried and stored in gelatin capsules, and the beaks were preserved in 70% ethanol.

We sorted and counted left and right fish otoliths and upper and lower cephalopod beaks using the larger count of each as the minimum number of individuals from each taxon. Identifications to the lowest possible taxon were made using reference collections at the SWFSC and the Santa Barbara Museum of Natural History (SBMNH), taxonomic keys to cephalopod beaks (Iverson and Pinkas, 1971; Clarke, 1986a), and previously published photographic identifications of fish otoliths (Fitch, 1967; Fitch and Brownell, 1968). Some of the recovered otoliths, however, were too worn to be identified to species.

The 36 specimens that were previously processed by other investigators generally had limited data available about the prey remains recovered. Omissions included the identity and

quantity of prey remains recovered and which stomach compartment had been examined. We identified the prey remains that had been preserved for these specimens, when possible. If this was not possible, we had to depend on the available notes for the identification of any prey that had been recovered.

RESULTS

Of the 77 stomachs in our sample, 38 were empty (Table 1) and the remaining 39 contained at least one prey item (Table 2). We identified 19 families of fish, 10 families of squid, and one species of crustacean among the prey remains recovered from the stomachs. Of these, only five fish families, two cephalopod families, and one species of crustacean were common to more than one of the cetacean species examined (Table 3). Market squid, Loligo opalescens, was the only prey species found in more than two of the cetacean species in our sample: common dolphin, bottlenose dolphin, Pacific white-sided dolphin, and short-finned pilot whale.

We have summarized a descriptive and comparative description of our findings by species in the following section. The percent frequency of occurrence (calculated as the number of stomachs in which a particular prey occurred as a percentage of the total number of stomachs examined) for each prey family identified is summarized in Table 4 by cetacean species. In the text, the percent frequency of occurrence of a prey taxon is given in parentheses for the cetacean species being discussed.

Species Accounts

Common dolphin -- There were 36 stomachs collected from beach-cast common dolphins (7 specimens were identified from the Baja neritic stock, 17 were from the northern temperate stock, and 12 were unidentifiable to stock; Evans, 1975; Perrin et al., 1985; Heyning and Perrin, 1991). In the sample, 19 specimens had empty forestomachs, and the remainder contained the remains of one or more species of fish, cephalopod, or crustacean.

Stomachs from five Baja neritic specimens were empty while the remaining two stomachs contained only fish otoliths. The two most frequently occurring prey items were northern anchovy, Engraulis mordax, (50.4%) and Pacific hake, Merluccius productus (42.4%; Table 5).

Stomachs from seven of the northern temperate specimens had empty stomachs, while 10 contained the remains of fish, squid, crustaceans, or some combination of these prey taxa (Table 5). The most frequently occurring prey for these animals were squid from the Family Gonatidae, representing a minimum of five species and 54.5% of the prey. The second and third most common prey items were market squid (17.0%) and Pacific hake (13.6%).

The stomachs from seven of the 12 common dolphin not identified to stock were empty.

One specimen had been examined previously, but the contents were discarded and therefore, we could not identify the prey species. The other four contained fish, squid, or both. The only prey species that could be identified were squid from the Family Gonatidae (Table 5).

Bottlenose dolphin -- Stomachs from 24 bottlenose dolphin were examined; 12 were empty, except for one forestomach that contained a metal spring (20 cm in diameter and 20 cm long). Prey remains were recovered from 12 specimens, but nine of these had been processed previously and neither prey identifications or counts of prey items were available. The small sample of identifiable prey from the remaining three stomachs, included species of croaker, Family Sciaenidae (29.2%); barracuda, Sphyræna argentea (4.2%); jack mackerel, Trachurus symmetricus (4.2%) and market squid (4.2%; Table 6). One stomach with prey remains also contained two #2 live bait hooks, each approximately 2.5 cm long.

Pacific white-sided dolphin -- Five of the seven Pacific white-sided dolphin specimens contained prey remains of fish, squid, or octopus (Table 6). In four of the stomachs, northern anchovy comprised 69.4% of the known total number of prey, and two species of octopus comprised 85.7% of the cephalopods recovered (Table 6). The fifth specimen was unusual in that the forestomach contained a minimum of 506 fish and cephalopods, and the main stomach contained a minimum of 191 fish and cephalopod remains (Table 7). In the forestomach of this individual, we identified prey items from 15 families of fish, one family of squid, and one family of octopus. Otoliths from the scorpionfish (Family Scorpaenidae) comprised 31.4% of all prey items recovered. The main compartment contained prey representing 10 families of fish, one family of squid, and one family of octopus. Toadfishes (Family Batrachoididae) were the most common fish species and represented 37.1% of the prey recovered. Otoliths from seven families of fish were present in the forestomach but not in the main compartment, and otoliths from two families were present in the main compartment but not in the forestomach.

Other species -- The remainder of the sample comprised two gray whales, one pygmy sperm whale, one Cuvier's beaked whale, two striped dolphins, two short-finned pilot whales, and two unidentified delphinid species. The stomachs collected from the gray whales, the striped dolphin, one of the short-finned pilot whales, and one of the unidentified delphinid species were empty of prey (Table 1). The stomach of one gray whale contained an unidentified liquid, sand, and an unidentified seaweed in both the forestomach and main stomach.

The stomach from the Cuvier's beaked whale contained an undetermined number of squid lenses, however, no beaks were found. A piece of black asphalt weighing 24.3g was also reported. The notes indicated that squid beaks and pens had been found in the colon and discarded. The striped dolphin stomach contained one gonatid squid beak. The short-finned pilot whale prey remains included a minimum of 29 squid, 25 of which were market squid (Table 8). The forestomach of the pygmy sperm whale contained one claw of a pelagic red crab, Pleuroncodes planipes, and fish otoliths. Data about the species and quantity of otoliths recovered were not available. The stomach collected from one of the unidentified delphinid specimens contained a minimum of 24 fish, 35 squid, and a jaw of an unidentified deep water fish. For this individual, Pacific hake otoliths (37.3%) were the only identifiable fish remains,

and the umbrella squid, Histioteuthis heteropsis (42.4%), was the most common cephalopod (Table 9).

DISCUSSION

Undigested or partially digested food items are rarely recovered from the stomachs of stranded cetaceans because of the length of time between death and stranding (Ross, 1979). This may be because many single strandings result from death due to illness, and the illness may change the normal processes of digestion and egestion, cause regurgitation, or result in inappetence. Digestion is also unlikely to stop immediately at the time of death (Matthews, 1978). For these reasons, the information about diet obtained by examining the stomachs of stranded animals is difficult to interpret. The more pelagic cetacean species, for instance, may take longer to strand, and if prey remains are recovered, they are likely to be of near-shore prey species, and are thus, atypical. Or, perhaps an animal that is ill may become more of an opportunistic feeder. In general, recovery of prey is unlikely from ill animals, but if prey remains are recovered, they would most likely represent a normal diet because the cause of death would have been relatively sudden (Ridgway, 1972; Ridgway and Dailey, 1972; Ross, 1979; Mead, 1979). In our sample, 48% of the stomachs collected were empty, and several of the rare specimens in our sample had obviously unusual items recovered that could be considered indicative of inappetence, opportunistic feeding or altered digestive processes.

Beach-cast specimens that apparently died suddenly of unnatural causes (e.g., fishery interactions) are the most likely type of specimen to provide a representative description of diet for that species (DeMaster et al., 1985). In our sample, only two specimens were identified as incidental fishery takes (2.7%), although, for 62.2% of the sample, cause of death could not be determined.

Actual numbers of each prey species eaten per meal is not easily or accurately determined by examination of prey remains in the stomach because rates of digestion are not known and differ between prey species. Also, while egestion rates for beaks and otoliths are approximately equal, digestion rates are not (Ross, 1979). Otoliths are worn by digestion and frequently cannot be identified. Distinguishing secondary prey items from primary prey is not possible for the same reasons. At best, our estimates of prey numbers are a minimum, given that the number of secondary prey items is negligible. Estimates of the number of prey in a stomach based upon the highest number of left and right otoliths or upper and lower beaks per each taxon are also considered conservative because the prey items are unlikely to all be pairs (Frost, 1924).

The importance of cephalopods as prey may be overestimated because chitinous beaks are less digestible than otoliths and may accumulate over several feedings (Ross, 1979; Stroud et al., 1981; Clarke, 1986b; Walker et al., 1986). Additionally, some of the smaller otoliths and beaks are likely to be secondary prey. For instance, Pacific hake has been known to prey on northern anchovy, market squid, and juvenile hake (Alton and Nelson, 1970; Fiscus, 1977). Market squid is also preyed upon by plainfin midshipman (Porichthys notatus), hake, white croaker, rockfish,

and Pacific sanddab (Citharichthys sordidus); all of these predators were identified in our sample.

The identification of prey items can be used to infer the distribution of the predator or prey. Some cetaceans have a tendency to respond to the seasonality of prey in a particular area. Coastal species, in particular, have been observed to move inshore and offshore seasonally, but whether this pattern is due to changes in oceanographic conditions, prey distributions, or a combination of both is unknown (Brown and Norris, 1956; Jones, 1981; Fiscus, 1982).

In our sample, the common dolphin, a pelagic species that is most abundant in June, September, October, and January off the southern California coast (Leatherwood et al., 1982; Leatherwood et al., 1983), had prey remains from pelagic schooling fish (i.e., Pacific hake and northern anchovy). Pacific hake is most abundant off the coast of California in late fall to spring (Nelson and Larkins, 1970) and comprised 32.0% of the total prey consumed by the common dolphins that stranded in spring. Northern anchovy, the next most frequently recovered prey item (29% of all prey), is found in abundance offshore in tightly packed schools from the surface of the water to depths of 220 meters (Eschmeyer et al., 1983; Miller and Lea, 1972). Anchovy school sizes are largest in April or May (Mais, 1974). We identified northern anchovy otoliths only in a Baja neritic common dolphin that stranded in April.

Both coastal and offshore populations of bottlenose dolphin occur off the coast of southern California (Walker et al., 1984). Little is known about the feeding habits of these populations, but our findings are similar to those reported for bottlenose dolphins found in similar habitats off the coasts of Texas and the northeastern U. S. (Leatherwood, 1975). The small sample of prey remains recovered from the dolphins in our study comprised croakers, barracuda, and market squid. All of these species are characteristic of inshore, temperate waters. Although croakers and barracuda are generally located in shallow waters, they are also found in water as deep as 600 meters (Eschmeyer et al., 1983). Croakers have been reported as prey for bottlenose dolphin off Texas (Caldwell and Caldwell, 1972; Gunter, 1942) and the northeastern U. S. coast (Leatherwood et al., 1978). The loliginid squid has also been previously reported as prey for the bottlenose dolphins in Texas (Kemp, 1949) and along the northeastern U. S. coast (Leatherwood et al., 1978).

In southern California, Pacific white-sided dolphin are found inshore during the winter and spring months and offshore during the summer and fall. Seasonal movements appear to be correlated with water temperature rather than with prey species because the dolphins have been observed to consume a wide variety of prey and recovered remains reflect the most abundant prey species of the area at a particular time (Brown and Norris, 1956; Jones, 1981).

One Pacific white-sided dolphin in our study is notable because both the forestomach and main stomach were full and contained cephalopod beaks, eye lenses, fish vertebrae and otoliths (Table 7). We specifically noted the food items recovered from the main stomach because of the rarity of this occurrence; the most recent meal is found in the forestomach (Turner, 1889; Harrison et al., 1970). The rarity of remains recovered from the main stomach may be due to the small size of the opening between the forestomach and the main stomach limiting passage of

prey between the two compartments or differential digestion rates and the amount of time between meals (Harrison et al., 1970). Compared to the other cetacean species in our study, this individual had the remains of a highly varied diet consisting of a minimum of 17 species of fish, one species of squid, and one species of octopus. All of these prey are commonly found off the coast of southern California. The depth ranges of all of the identified fish species and the market squid overlap in shallow waters (Miller and Lea, 1972; Hixon, 1983). Our findings are similar to those reported in previous food habit studies for this species (Table 10).

Stomach contents of several short-finned pilot whale specimens collected in southern California have been described (Berry, 1912; Hacker, 1986; Kritzler, 1952; Hall et al., 1971; Seagers and Henderson, 1985). Short-finned pilot whales are most abundant in southern California waters from December through February. Market squid, robust-hooked squid, and umbrella squid were all found in the stomachs of short-finned pilot whales in our sample. These are the same prey species reported for specimens previously sampled from southern California (Hacker, 1986; Hall et. al., 1971). Seagers and Henderson (1985) reported observing a pilot whale feeding on market squid near Santa Catalina Island. The robust-hooked squid, however, is rarely sighted south of Point Conception, California (Hochberg, 1974; Seagers and Henderson, 1985; Hacker, 1986).

There were several prey species found to be unique to one species of cetacean. This may be because certain prey are preferred or feeding is opportunistic and the prey represent what is available in a particular area (Evans, 1987). Or, on the otherhand, this may be the result of small sample size for any particular species. For example, four families of squid were recovered only from the northern temperate common dolphins in our sample (Table 5). These species of cephalopods have a mid-water, offshore distribution (Clarke, 1986b), possibly explaining the absence of these prey species in the more coastal Baja neritic stock of common dolphin. Our results also suggest that the two stocks of common dolphin further differ in diet, and perhaps occupy different niches, because northern anchovy remains were found only in the Baja neritic stock specimens. The Pacific white-sided dolphin prey consisted of 12 families of coastal fish species found at mid-water depths and on the bottom and none of these species were identified as prey of any of the other cetaceans (Tables 4, 5; Miller and Lea, 1972). These results substantiate that this species is a generalized, opportunistic, feeder as suggested by Jones (1981).

Our results provide information about the diet of cetaceans found along the coast of southern California for which little is known. In most cases, our results corroborate previous findings. While there are some inherent problems with studying food habits from stranded cetaceans, these studies do provide information about the diets of cetaceans that are not otherwise available.

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Table 1. Collection data recorded for beach-cast cetaceans with empty stomachs collected along the San Diego County coast (n=38).

Specimen No.	Collection		Sex	Specimen length (cm)	Cause of Death
	Date	Latitude			

Common dolphin - Baja neritic stock

JRH 049	07/26/79	32° 58' N	117° 16' W	M	230.9	Sepsis
LJH 094	05/19/83	33° 02' N	117° 17' W	M	179.8	Unknown
LJH 121	10/16/83	32° 40' N	117° 10' W	F	205.0	Unknown
HJB 013	03/25/85	32° 57' N	117° 16' W	M	222.5	Pulmonary edema
HJB 049	08/21/87	33° 01' N	117° 17' W	F	200.5	Unknown

Common dolphin - northern temperate stock

NUC 417	09/13/75	-- -- N	117° -- W	M	184.5	Unknown
NUC 409	07/10/76	-- -- N	117° -- W	M	192.9	Unknown
JRH 071	07/29/80	33° 08' N	117° 20' W	M	190.0	Unknown
LJH 106	08/22/83	33° 09' N	117° 21' W	M	159.1	Possible boat accident
HJB 001	07/19/84	33° 08' N	117° 20' W	M	155.0	Unknown
HJB 004	11/15/84	32° 44' N	117° 11' W	M	190.5	Unknown
HJB 037	10/16/86	32° 43' N	117° 13' W	M	193.0	Unknown

Common dolphin - stock unknown

NUC 204	03/30/72	32° 58' N	117° 16' W	M	184.0	Unknown
NUC 385	04/27/74	-- -- N	117° -- W	F	146.0	Unknown
NUC 397	08/05/75	-- -- N	117° -- W	F	179.0	Unknown
WFP 560	03/27/77	-- -- N	117° -- W	M	200.0	Unknown
SWC8436B	04/20/84	-- -- N	117° -- W	M	191.0	Unknown
HJB 017	05/03/85	32° 32' N	117° 08' W	-	165.0	Unknown
HJB 026	11/02/86	33° 01' N	117° 17' W	F	207.0	Unknown

Bottlenose dolphin

WFP 509	10/22/75	-- -- N	117° -- W	F	201.8	Unknown
JRH 067	07/07/80	32° 38' N	117° 08' W	M	131.0	Sepsis
JRH 070	07/24/80	32° 48' N	117° 16' W	F	127.4	Stillbirth
JRH 077	09/10/80	32° 53' N	117° 15' W	M	121.2	Pneumonia
JRH 098	12/31/80	32° 54' N	117° 15' W	M	340.0	Unknown
LJH 066	07/29/82	32° 53' N	117° 15' W	F	86.5	Stillbirth
MSL 267	10/05/82	33° 06' N	117° 19' W	M	205.9	Hemorrhagic pneumonia
MSL 269	10/15/82	33° 06' N	117° 19' W	M	240.6	Erysipelas
LJH 096	05/25/83	33° 13' N	117° 25' W	F	126.2	Stillbirth
HJB 018	06/11/85	32° 38' N	117° 08' W	M	124.9	Stillbirth
HJB 048	06/24/87	33° 06' N	117° 19' W	M	241.8	Cardiopulmonary infection?
KZP 018	08/03/90	32° 54' N	117° 15' W	F	129.1	Stillbirth?

Pacific white-sided dolphin

LJH 012	02/03/82	33° 08' N	117° 20' W	M	186.7	Unknown
KZP 005	05/10/89	33° 00' N	117° 16' W	F	179.3	Unknown

Short-finned pilot whale

WFP 249	03/15/73	32° 53' N	117° 15' W	F	436.5	Unknown
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Striped dolphin

LJH 082	03/15/83	33° 16' N	117° 26' W	M	211.4	Unknown
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Gray whale

JRH 055	03/30/80	32° 45' N	117° 15' W	M	1240.0	Unknown
LJH 123	08/26/82	32° 42' N	117° 14' W	F	712.0	Pneumonia

Unidentified delphinid

HJB 026	02/11/86	33° 01' N	117° 17' W	F	207.0	Unknown
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Table 2. Collection data recorded for beach-cast cetaceans along the San Diego County coast with non-empty stomachs (n=39). "Stomach" refers to the stomach compartment in which prey remains were found: E = esophageal compartment; E,M = contents found in both the esophageal and main compartments; E+M = combined contents of esophageal and main compartments.

Specimen No.	Collection			Sex	Specimen length (cm)	Stomach	Cause of Death
	Date	Latitude	Longitude				
Common dolphin - Baja neritic stock							
HJB 029	04/14/86	33° 03' N	117° 18' W	F	211.6	E	Gill net?
HJB 031	04/24/86	33° 00' N	117° 17' W	M	220.0	E	Pneumonia
Common dolphin - northern temperate stock							
WFP 558	01/27/77	-- -- N	117° -- W	M	186.4	E+M	Unknown
NUC 420	02/13/78	32° 57' N	117° 16' W	M	198.1	E+M	Unknown
WFP 595	05/11/79	33° 03' N	117° 18' W	F	175.6	E+M	Hemorrhagic pneumonia
JRH 074	08/13/80	32° 42' N	117° 14' W	M	174.9	E+M	Cerebral necrosis
LJH 054	06/02/82	33° 23' N	117° 36' W	F	184.1	E+M	Hepatitis
HJB 003	11/06/84	33° 22' N	117° 33' W	M	203.0	E+M	Hyperthermia/exhaustion
HJB 010	03/20/85	33° 22' N	117° 34' W	F	183.1	E,M	Hepatitis
HJB 030	04/15/86	32° 47' N	117° 15' W	M	195.0	E	Pneumonia/Septicemia?
HJB 032	05/02/86	-- -- N	117° -- W	M	189.4	E	Septicemia
KZP 014	02/21/90	32° 52' N	117° 15' W	F	189.0	E	Unknown
Common dolphin - stock unknown							
NUC 215	04/10/72	33° 09' N	117° 21' W	F	193.6	E	Unknown
WFP 217	04/11/72	32° 51' N	117° 16' W	M	187.4	E	Unknown
WFP 485	03/11/75	33° 04' N	117° 18' W	M	187.2	E+M	Unknown
JRH 141	05/25/81	32° 48' N	117° 16' W	F	187.0	E?	Unknown/774
HJB 044	03/30/87	32° 56' N	117° 16' W	F	140.0	E	Unknown
Bottlenose dolphin							
WFP 522	07/27/76	32° 56' N	117° 16' W	F	210.8	E+M	Unknown
WFP 523	08/02/76	32° 33' N	117° 08' W	F	255.2	E+M	Unknown
WFP 535	08/09/76	32° 54' N	117° 15' W	M	313.0	E+M	Unknown
WFP 537	08/31/76	33° 03' N	117° 18' W	F	183.0	E+M	Unknown
WFP 559	02/07/77	32° 53' N	117° 15' W	M	302.8	E	Gunshot?
WFP 565	06/27/77	32° 57' N	117° 16' W	M	266.9	E+M	Unknown
JRH 073	08/03/80	33° 22' N	117° 34' W	F	309.0	E,M	Unknown
LJH 006	11/14/81	32° 52' N	117° 15' W	F	235.7	M	Unknown
LJH 105	08/10/83	33° 22' N	117° 33' W	F	289.5	E+M	Unknown
HJB 019	06/14/85	32° 56' N	117° 16' W	F	283.0	E	Abdominal wall perforation
HJB 036	09/03/86	-- -- N	117° -- W	M	-----	E+M	Unknown
JVK 046	05/17/91	-- -- N	117° -- W	F	288.0	E+M	Unknown
Pacific white-sided dolphin							
JRH 054	03/06/80	33° 05' N	117° 19' W	F	187.0	E+M	Unknown
LJH 077	01/12/83	32° 55' N	117° 16' W	F	221.0	E+M	Hemorrhagic pneumonia
LJH 119	09/23/83	32° 58' N	117° 16' W	F	216.4	E+M	Unknown
HJB 022	09/25/85	32° 32' N	117° 08' W	F	223.0	E,M	Unknown
HJB 025	10/22/85	32° 47' N	117° 15' W	M	195.2	E,M	Unknown
Short-finned pilot whale							
JRH 086	11/04/80	33° 23' N	117° 34' W	M	316.0	E+M	Unknown
Striped dolphin							
LJH 086	05/03/83	33° 03' N	117° 18' W	F	211.2	E+M	Unknown
Pygmy sperm whale							
HJB 005	12/18/84	32° 34' N	117° 08' W	F	148.0	E	Circulatory collapse
Cuvier's beaked whale							
JRH 087	11/20/80	32° 54' N	117° 15' W	M	526.0	E+M	Nephritis
Unidentified delphinid							
MSL 290	04/15/83	33° 04' N	117° 30' W	-	214.0	E	Unknown

Table 3. Prey species recovered from the stomachs of at least two of the following cetacean species: common dolphin, bottlenose dolphin, Pacific white-sided dolphin, pygmy sperm whale and short-finned pilot whale.

Prey family/species	Common dolphin	Bottlenose dolphin	Pacific white- sided dolphin	Pygmy sperm whale	Short-finned pilot whale
Engraulidae					
<u>Engraulis mordax</u>	x		x		
Carangidae					
<u>Trachurus symmetricus</u>		x	x		
Galatheididae					
<u>Pleuroncodes planipes</u>	x			x	
Gonatidae					
<u>Gonatus berryi</u>	x		x		
Loliginidae					
<u>Loligo opalescens</u>	x	x	x		x
Merluccidae					
<u>Merluccius productus</u>	x		x		
Sciaenidae					
<u>Genyonemus lineatus</u>	x		x		
unidentified Sciaenids		x	x		
Scombridae					
<u>Scomber japonicus</u>	x	x			
Sphyraenidae					
<u>Sphyraena argentea</u>		x	x		

Table 4. Frequency of occurrence for each prey Family is summarized by cetacean species. Numbers are in percentages and were calculated using total amount of prey remains found in the fore and main stomachs. Cuvier's beaked whale, striped dolphin and the pygmy sperm whale all contained traces of prey which could not be reported as percentages.

Prey Family	Common dolphin	Bottlenose dolphin	Pacific white-sided dolphin	Short-finned pilot whale	Unidentifed Delphinid
<u>Fish</u>					
Batrachoididae	--	--	14.97	--	--
Bothidae	--	--	0.30	--	--
Carrangidae	--	4.17	0.90	--	--
Clupeidae	3.23	--	--	--	--
Embiotocidae	--	--	0.30	--	--
Engraulidae	29.00	--	23.56	--	--
Exocoetidae	--	--	0.20	--	--
Gobiidae	--	--	0.10	--	--
Kyphocidae	--	--	0.10	--	--
Labridae	--	--	0.10	--	--
Merluccidae	24.40	--	6.19	--	37.29
Ophiidae	--	--	1.20	--	--
Pleuronectidae	--	--	0.30	--	--
Pomacentridae	--	--	3.59	--	--
Sciaenidae	0.46	29.17	5.79	--	--
Scombridae	0.46	--	0.40	--	--
Scorpaenidae	--	--	20.46	--	--
Serranidae	--	--	0.60	--	--
Sphyraenidae	--	4.17	0.10	--	--
Unid. fish	--	50.00	.20	--	3.39
<u>Cephalopods</u>					
Argonautidae	0.46	--	--	--	--
Chiroteuthidae	1.30	--	--	--	--
Enoplateuthidae	0.92	--	--	--	6.78
Gonatidae	23.50	--	0.10	3.45	10.17
Histioteuthidae	0.46	--	--	--	42.37
Loliginidae	6.91	4.17	2.40	86.20	--
Mastoteuthidae	0.46	--	--	--	--
Octopodidae	--	--	17.17	--	--
Onychoteuthidae	--	--	--	10.35	--
Vampyroteuthidae	2.30	--	--	--	--

Table 5. Summary of prey remains from stomachs of common dolphin: Baja neritic (n = 2), northern temperate (n = 10), stock unknown (n = 5). "No. of Prey" is the minimum number of each prey species represented. The superscripts following the Specimen Numbers refer to the stomach compartment in which the prey remains were found: E = esophageal compartment; E+M = combined contents of esophageal and main compartments. "+" refers to the presence of additional prey whose species and quantities are unknown.

<u>Clupeidae</u>									
<u>Sardinops caeruleus</u>	7	7	HJB 029	0	0	--	0	0	--
<u>Engraulidae</u>									
<u>Engraulis mordax</u>	63	63	HJB 029	0	0	--	0	0	--
<u>Merlucciidae</u>									
<u>Merluccius productus</u>	53	53	HJB 029; HJB 031	12	12	HJB 010	0	0	--
<u>Sciaenidae</u>									
<u>Genyonemus lineatus</u>	1	1	HJB 029	0	0	--	0	0	--
<u>Scombridae</u>									
<u>Scomber japonicus</u>	1	1	HJB 029	0	0	--	0	0	--
<u>unidentified fish</u>	0	0	--	+	+	HJB 030	+	+	WFP 217; WFP 485
<u>Cephalopods</u>									
<u>Argonautidae</u>									
<u>Argonauta cf. nouryi</u>	0	0	--	-	1	HJB 003	0	0	--
<u>Chiroteuthidae</u>									
<u>Chiroteuthis calyx</u>	0	0	--	-	3	HJB 003	0	0	--
<u>Enoplateuthidae</u>									
<u>Abraliopsis felis</u>	0	0	--	-	2	HJB 003	0	0	--
<u>Gonatidae</u>									
<u>Gonatopsis borealis</u>	0	0	--	8	18	WFP 595; HJB 003; HJB 010; HJB 032; KZP 014	0	0	.
<u>Gonatus berryi</u>	0	0	--	8	10	HJB 003; HJB 032	3	3	HJB 044
<u>G. cf. berryi</u>	0	0	--	2	2	HJB 032	0	0	--
<u>G. cf. californiensis</u>	0	0	--	-	1	WFP 595	0	0	.
<u>G. onyx</u>	0	0	--	10	12	HJB 032; KZP 014	0	0	--
<u>Unidentified gonatids</u>	0	0	-	3	5	HJB 003; KZP 014	0	0	.
<u>Histioteuthidae</u>									
<u>Histioteuthis heteropsis</u>	0	0	--	1	1	WFP 595; KZP 014	0	0	--
<u>Unidentified histioteuthidae</u>	0	0	--	3	-	KZP 014	0	0	--
<u>Loliginidae</u>									
<u>Loligo opalescens</u>	0	0	--	1	15	WFP 558; HJB 032	0	0	--
<u>Mastigoteuthidae</u>									
<u>Mastigoteuthis pyrodes</u>	0	0	--	-	1	HJB 003	0	0	--
<u>Vampyroteuthidae</u>									
<u>Vampyroteuthis infernalis</u>	0	0	--	-	1	HJB 003	0	0	--
<u>unidentified cephalopods</u>	+	+	HJB 031	4+	4+	NUC 420; LJH 054	1+	1+	NUC 215; LJH 054; WFP 217
<u>unidentified prey</u>	0	0	--	+	+	HJB 030; KZP 014 JRH 074	0	0	--
<u>Total</u>	125+	125+		52+	88+		4+	4+	

Table 6. Summary of prey remains from stomachs of bottlenose dolphin (n=10) and Pacific white-sided dolphin (n=4). 'No. of Prey' is the minimum number of prey species represented. The subscripts following the 'Specimen numbers' refer to the stomach compartment in which the prey remains were found: E= esophageal, M= main, E+M= combined contents of both the esophageal and main compartments. A '+' indicates the presence of additional prey whose species and quantities are unknown.

Food items	Bottlenose dolphin			Pacific white-sided dolphin		
	No. of Prey		Specimen	No. of Prey		Specimen
	E	E+M	numbers	E	E+M	numbers
Fish						
Batrachoididae						
<u>Porichthys myriaster</u>	0	0	--	-	2	LJH 119
<u>P. notatus</u>	0	0	--	-	26	LJH 119
Carangidae						
<u>Trachurus symmetricus</u>	0	1	JVK 046	0	0	--
Engraulidae						
<u>Engraulis mordax</u>	0	0	--	-	211	LJH 119
Ophiidae						
<u>Chilara taylori</u>	0	0	--	-	5	LJH 119
Pomacentridae						
<u>Chromis punctipinnis</u>	0	0	--	-	22	LJH 119
Sciaenidae						
<u>Cynoscion nobilis</u>	1	1	HJB 019	0	0	--
<u>Roncador stearnsi</u>	1	1	HJB 019	0	0	--
<u>Seriophus politus</u>	1	1	HJB 019	0	0	--
Unidentified Sciaenids	4	4	HJB 019	-	1	LJH 077
Scombridae						
<u>Scomber japonicus</u>	0	0	--	-	4	LJH 119
Unidentified Scombrids	0	0	--	-	1	LJH 119
Scorpaenidae						
<u>Sebastes</u> spp.	0	0	--	-	17	LJH 119
Serranidae						
<u>Paralabrax nebulifer</u>	0	0	--	-	1	LJH 077
Sphyraenidae						
<u>Sphyraena argentea</u>	1	1	HJB 019	0	0	--
unidentified fish	3	12+	WFP 522; WFP 523; WFP 535; WFP 537; WFP 565; JRH 073; HJB 036	0	0	--
Cephalopods						
Goniatidae						
<u>Gonatus</u> sp.	0	0	--	-	1	LJH077
Unidentified Gonatids	0	0	--	0	0	--
Histioteuthidae						
<u>Histioteuthis heteropsis</u>	0	0	--	0	0	--
Loliginidae						
<u>Loligo opalescens</u>	1	1	WFP 559	-	1	LJH 077
Octopodidae						
<u>Octopus rubescens</u>	0	0	--	1	5	LJH 119; HJB 025
<u>Octopus</u> sp.	0	0	--	-	7	LJH 077
unidentified cephalopods	1	2	WFP 565; JRH 073; LJH 006	-	+	JRH 054
unidentified prey	+	+	LJH 105	0	0	--
Total	13	24+		1	304+	

Table 7. Summary of prey remains reported taken from the esophageal and main compartments of one Pacific white-sided dolphin (HJB 022).

Prey items	Esophageal No. of Prey	Main No. of Prey
Fish		
Batrachoididae		
<u>Porichthys myriaster</u>	3	6
<u>P. notatus</u>	48	65
Bothidae		
<u>Citharichthys sordidus</u>	3	0
Carangidae		
<u>Trachurus symmetricus</u>	5	4
Embiotocidae	3	0
Engraulidae		
<u>Engraulis mordax</u>	23	2
Exocoetidae		
cf. <u>Cypselurus californicus</u>	2	0
Gobiidae	0	1
Kyphocidae		
cf. Kyphocidae	1	0
Labridae		
<u>Oxyjulis californica</u>	0	1
Merluccidae		
<u>Merluccius productus</u>	36	26
Ophiidae		
<u>Chilara taylori</u>	5	0
<u>Otophidium scrippsi</u>	2	0
Pleuronectidae		
<u>Microstomas pacificus</u>	0	1
<u>Parophrys vetulus</u>	2	0
Pomacentridae		
<u>Chromis punctipinnis</u>	12	2
Sciaenidae		
<u>Genyonemus lineatus</u>	53	2
unidentified Sciaenids	2	0
Scorpaenidae		
<u>Sebastes spp.</u>	159	29
Serranidae		
<u>Paralabrax clathratus</u>	3	0
<u>P. nebulifer</u>	1	0
unidentified Serranids	1	0
Sphyraenidae		
<u>Sphyraena argentea</u>	1	0
unidentified flatfish	2	1
unidentified otoliths	8	0
Cephalopods		
Loliginidae		
<u>Loligo opalescens</u>	14	9
Octopodidae		
<u>Octopus rubescens</u> ^a	116	42
<u>O. cf. rubescens</u>	1	0
Total	506	191

^a Individuals of a second species may be included here (F. Hochberg, pers. comm.).

Table 8. Summary of prey remains from stomachs of Cuvier's beaked whale (n=1), striped dolphin (n=1), and short-finned pilot whale (n=1). 'No. of Prey' is the minimum number of prey species represented. The subscripts following the 'Specimen numbers' refer to the stomach compartment in which the prey remains were found: E= esophageal, M= main, E+M= combined contents of both the esophageal and main compartments. A '+' indicates the presence of additional prey whose species and quantities are unknown. No fish remains were present in these stomachs.

	<u>Cuvier's beaked whale</u>			<u>Striped dolphin</u>			<u>Short-finned pilot whale</u>		
	<u>No. of Prey</u>		<u>Specimen numbers</u>	<u>No. of Prey</u>		<u>Specimen numbers</u>	<u>No. of Prey</u>		<u>Specimen numbers</u>
	<u>E</u>	<u>E+M</u>		<u>E</u>	<u>E+M</u>		<u>E</u>	<u>E+M</u>	
Cephalopods									
Gonatidae									
<u>Gonatus</u> sp.	0	0	--	0	0	--	0	0	--
Unidentified Gonatids	0	0	--	-	1	LJH 086	0	0	--
Histioteuthidae									
<u>Histioteuthis heteropsis</u>	0	0	--	0	0	--	-	1	JRH 086
Loliginidae									
<u>Loligo opalescens</u>	0	0	--	0	0	--	-	25	JRH 086
Onychoteuthidae									
<u>Moroteuthis robusta</u>	0	0	--	0	0	--	-	3	JRH 086
unidentified cephalopods	-	+	JRH 087	0	0	--	0	0	--
Total	0	+		-	1		-	29	

Table 9. Summary of prey remains from the stomachs from one pygmy sperm whale (HJB 005) and one unidentified delphinid (MSL 290). "No. of Prey" is the minimum number of each prey species represented. "+" refers to the presence of additional prey whose species and quantities are unknown.

	<u>Pygmy sperm whale</u>	<u>Unid. delphinid</u>
<u>Food item</u>	<u>No. of</u>	<u>No. of</u>
	<u>Prey</u>	<u>Prey</u>
Fish		
Merluccidae		
<u>Merluccius productus</u>	0	22
unidentified fish	+	2
Cephalopods		
Enoploteuthidae	0	4
Gonatidae		
<u>Gonatus berryi</u>	0	5
<u>Gonatus sp.</u> ^a	0	1
Histiotteuthidae		
<u>Histiotteuthis heteropsis</u>	0	25
Crustacean		
Galatheididae		
<u>Pleuroncodes planipes</u>	1	0
Total	1+	59

^a This is a not yet identified species (F. Hochberg, pers. comm.).
Refer to Mead et al. 1982.

Table 10. List of fish and cephalopod remains found in stomachs of common or Pacific white-sided dolphins in this study and in previous studies of these dolphin species from the North Pacific Ocean.

Prey species	Common dolphin	Pacific white-sided dolphin
Pacific sardine, <u>Sardinops caeruleus</u>	Norris and Prescott 1961; this study	Brown and Norris 1956; Norris and Prescott 1961; Fiscus and Niggol 1965; Fitch and Brownell 1968; Morejohn 1977; Morejohn <u>et al.</u> 1978; Kajimura <u>et al.</u> 1980; Stroud <u>et al.</u> 1981; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Northern Anchovy, <u>Engraulis mordax</u>	Brown and Norris 1956; Norris and Prescott 1961; Fitch and Brownell 1968; Evans 1975; Smith 1976; Evans draft ¹ ; this study	Scheffer 1953; Fiscus and Niggol 1965; Fitch and Brownell 1968; Morejohn 1977; Morejohn <u>et al.</u> 1978; Kajimura <u>et al.</u> 1980; Stroud <u>et al.</u> 1981; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Pacific Hake, <u>Merluccius productus</u>	Fitch and Brownell 1968; Evans 1975; Evans draft ¹ ; this study	Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
White croaker, <u>Gonyonemus lineatus</u>	this study	Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Specklefin midshipman, <u>Porichthys myriaster</u>		Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Plainfin midshipman, <u>P. notatus</u>		Jones 1981; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Pacific sanddab, <u>Citharichthys sordidus</u>		Kajimura <u>et al.</u> 1980; Stroud <u>et al.</u> 1981; this study
Jack Mackerel, <u>Trachurus symmetricus</u>		Kajimura <u>et al.</u> 1980; Stroud <u>et al.</u> 1981; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Spotted cusk-eel, <u>Chilara taylori</u>		Morejohn 1977; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Rockfishes, <u>Sebastes</u> spp.		Morejohn 1977; Morejohn <u>et al.</u> 1978; Kajimura <u>et al.</u> 1980; Stroud <u>et al.</u> ; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Flatfish		Morejohn 1977; this study
Gonate squid, <u>Gonatus</u> sp.	Fiscus and Niggol 1965; this study	
Market squid, <u>Loligo opalescens</u>	this study	Brown and Norris 1956; Norris and Prescott 1961; Morejohn <u>et al.</u> 1978; Kajimura <u>et al.</u> 1980; Stroud <u>et al.</u> 1981; Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study
Octopus, <u>Octopus</u> sp.		Walker <u>et al.</u> 1984; Walker <u>et al.</u> 1986; this study

¹ Evans, W. E. Draft. Delphinus, anchovy, squid, hake relationship in southern California waters. 7 p.

